

LCA Software

LCA Software Review

Comparison of Currently Available European LCA Software

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Abstract

Twelve of the main European LCA software packages currently available are examined with the aim of establishing which are the most appropriate for LCAs on industrial processes. The packages performances are assessed in terms of

- Volume of Data
- WindowsTM environment
- Network Capabilities
- Impact Assessment
- Graphical representation of the inventory results
- Sensitivity analysis
- Units
- Cost
- User Support
- Flow Diagrams
- Burdens allocation
- Transparency of data
- Input & output parameters
- Demo version
- Quality of data

The review concludes with a Specification Table which summarises the facilities available on each software package.

The general conclusion from this study is that for industrially based LCAs, there are four packages which may offer advantages over the rest. These are The Boustead Model, The Ecobilan Group's TEAMTM, PEMS 3.0 and SimaPro 3.1.

The report examines twelve of the current software packages used for producing Life Cycle Inventories (LCIs) as part of an overall life cycle analysis (LCA). Other European software houses were contacted for information on their software, but did not respond. Only the leading European software has been examined, although there are many software packages generated globally. The packages examined are

- The Boustead Model
- EcoPro 1.3
- GaBi 2.0
- KCL-ECO (with ECODATA database)
- LCAiT 2.0
- LMS Eco-Inventory Tool¹
- Oeko-Base für Windows
- PEMS 3.0
- PIA
- SimaPro 3.1
- SimaTool
- The Ecobilan Group's TEAMTM (with DEAMTM database)

Each software package has its merits and its drawbacks, either in terms of price or functionality. Their features are discussed in the appropriate section and in the conclusions.

The review was initiated to identify packages suitable for LCAs on UK-based industrial applications. The information given in this article is, however, equally appropriate to European applications and much of the commentary is also appropriate internationally.

1 Introduction

This article has been extracted from a comprehensive report on the software listed. For more information, and for copies of the report please contact the corresponding author [1]. The aim of this study was to examine the available software appropriate to European industrial LCAs and make recommendations on which software would be the most suitable. The main methods for assessing the packages detailed in the report were by

- demonstration disks supplied by the appropriate software houses
- current literature on the databases available
- one to one demonstrations of the software
- feedback from the software houses concerning the draft report
- discussing software with users.

2 General Points

It is assumed within this report that the reader is familiar with the basic principles of LCA, but it is worthwhile briefly examining the fundamental structure of life cycle analysis before reviewing the individual software available.

¹ It should be pointed out that LMS Eco-Inventory Tool has a slightly different functionality to the other software reviewed here. It is part of a comprehensive environmental management tool which is designed to be very site specific. The inventory results generated are based on data related predominantly to the site concerned. Improvement analysis is based on the user identifying areas for enhanced process efficiency. Results are not intended for global interpretation.

LCA can be separated into several specific stages as detailed by SETAC [2]. Each of stages is interrelated, so the LCA practitioner often migrates back and forth between stages during the course of an analysis. These stages are represented in Figure 1.

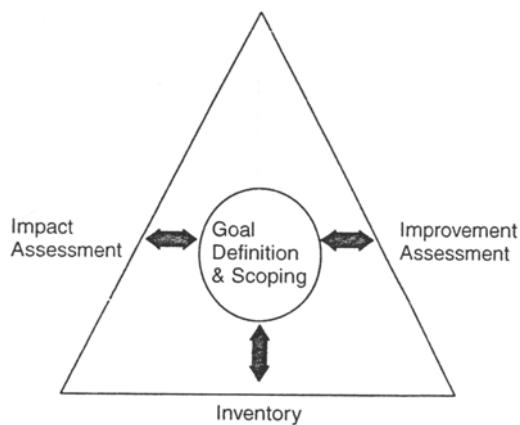


Fig. 1: Graphical representation of the stages involved [2]

The first stage is goal definition and scoping, where the purpose of the project is established, and the general project plan and boundaries are determined. Generating the Inventory involves collecting data and calculating the emissions and burdens associated with a specific functional unit. Once the inventory has been calculated, the impact assessment may be completed to establish the potential and actual environmental and human health effects related to the use of resources and environmental releases. The final stage of LCA is Improvement Assessment, where changes needed to bring about environmental improvements are reviewed.

All the software packages are essentially similar in their aims. The basic function of any package is to complete energy and mass balances on an item specified by the user and then allocate emissions, energy uses etc normalised on some common basis, usually mass.

All packages are designed to aid the user in the inventory stage of LCA, and in this respect two parameters are of importance. These are

- the volume, quality, accuracy and relevance of data available to the user on the supplied software, and
- the ease of use of that software package (ie, Is the package clearly set up? Does it run in Windows™? Does it perform impact assessment and does it produce graphical outputs etc? How accurate & consistent are the results generated by the software? What support is provided with the package?)

3 Volume of Data

When discussing data, two issues should be considered. Firstly the volume and appropriateness of data supplied with the software is important.

Many European software houses supply databases with data appropriate to international applications. However, LiMS (Life Cycle Interactive Modelling system) from Chem Systems together with EcoManager™ and REPAQ™, the databases supplied from Franklin Associates come with data which is mainly appropriate to the United States [4]. Neither of these software packages are reviewed here.

Secondly, the packages' ability to process data and produce results quickly and accurately is important. Some software is faster than others. Although this is not an issue when investigating smaller systems, results for larger systems may take a substantial time to generate. Boustead's model has a reputation for slow computation of results. This is certainly true at system installation when performing calculations for core modules. When calculating actual user inventories, however, BOUSTEAD suggests that the process should not take any longer than a few minutes. Some users have questioned how packages such as PEMS 3.0 and LCAiT 2.0 can generate inventory results so quickly.

The volume of data associated with each of the packages varies widely. Some packages offer the option of purchasing them with or without data. Such packages include KCL-ECO and GaBi 2.0. This option is discussed later and it may be worthwhile where not all data are appropriate to the industry sector. The data offered by KCL for instance is mostly related to the Finnish pulp and paper industry, although the energy production data can be applied to any country if the user knows the fuel breakdown associated with the country in question [3]. The data offered with EcoPro 1.3 relates mostly to the packaging industry for which the package was designed, as does that associated with Oeko-Base für Windows.

None can surpass Boustead's model in terms of the magnitude of data supplied as standard with the software. However, some users have found this database relatively difficult to use, and have compensated for this by amalgamating the data from Boustead into the software from Pira. Pira is arguably the most user-friendly of all the software packages.

The Ecobilan Group advertise as having the world's largest and most up to date database but, the software does not come with all the data as standard [1]. DEAM™ has to be purchased in modules which range in prices from 2000FF to 20,000FF (or approximately £260 to £2600 based on an exchange rate at the time of writing of 7.7FF to the pound). However, the fee for data is once only, not annual. There is an option to purchase a one year extension of DEAM™ maintenance.

The issues of both quality of data and the standard format of data are currently being considered by the LCA community. SPOLD are currently attempting to introduce a common format for LCI data, and have set up a 'promoting sound practices' working group to encourage this.

The Ecobilan Group issues TEAM™ with site specific data which many experienced users consider to be a more accurate representation than averaged figures, but access to the data is restricted, and this has obvious effects on the trans-

Table 1: Cost of software

Package	Supplier	Software		Data (if appropriate)	
		Original currency	Sterling equivalent ²	Original currency	Sterling equivalent
Boustead (2)	Boustead	—	10,000 yearly	—	—
EcoPro 1.3	EMPA	8500 SFrancs	4620 ³	—	—
GaBi 2.0	IKP	14,000 DM	6400	See below ⁴	
KCL-ECO	KCL	15,000 FIM	2200	10,000+100 FIM	1500 + 15 per module
LCAiT 2.0	Chalmers Ind'	25,000 Krona	2400	—	—
LMS Eco-Inventory Tool	LMS Umweltsysteme		6200 ⁵ 12000	—	—
Oeko-Base	MGB	SF8500	4700	—	—
PEMS 3.0	Pira International	—	6000 + VAT ⁶	—	—
PIA	TME	2100 DGuilder	840	—	—
SimaPro 3.1	PRé	4800 DGuilder	1900	See below ⁷	
SimaTool	CML Leiden	4250 DGuilder	1700 ⁸	—	—
TEAM TM /DEAM TM	The Ecobilan Group	130,000 Franc 68,300 yearly	16,670 8,700 yearly	—	—

² Single payment unless otherwise stated³ Based on an exchange rate of 1.84 SFrancs to the pound. There are special conditions for universities and non-profit making organisations⁴ GaBi 2.0 can be purchased with a complete database, a partial database or only examples at 14,000, 12,000 and 4,000 DM respectively. An educational version is also available⁵ This price of LMS Eco-inventory Tool is for a single user. The cost of a network server configuration is £12000, plus £800 per additional user workstation. The price of the entire LMS/U1 Environmental management system is available on request⁶ Cost shown is for a site license. The option is also available to join the User Clut (at an annual cost of £1650 with associated benefits). First year membership is included in the price of the software. Single user license is £2500 (excluding User Club membership)⁷ SimaPro 3.1 can be purchased in several versions – a designer version, a more advanced Analyst version and a network version. The respective new licenses cost 2400, 4800 and 9600 (+2400 per extra user) Dutch guilders respectively. An educational version is also available.⁸ SimaTool comes with the ETH database on energy at no extra cost. However, the full report must be purchased from ETH in Zürich

pacity of the LCA data. Other suppliers (eg Pira, PRé Consultants, and Boustead) use averaged data with the associated reduction in accuracy. PIA provides data from different sources, thereby allowing sensitivity and reliability to be checked. Specific site data can also be included.

An important issue relating to data appropriateness already mentioned in this section, is that of average versus sites specific data. The accuracy of any LCA is directly related to the accuracy of the data used for that analysis. For a truly accurate analysis, all the data used in that analysis should be site specific *to that site*. Site specific data for another site is clearly less relevant, and may not even be as appropriate as average data, depending on the geographic and temporal area over which the data is averaged (and its depth and degree of detail).

Thus, the option of purchasing LCA software without data is a possibility that should be considered. Packages such as TEAMTM, GaBi 2.0 and KCL-ECO offer this option.

4 WindowsTM Environment

For easier incorporation of results into reports etc and for manipulation of inventory results into MS-OfficeTM based spreadsheets, WindowsTM based software is useful. If it is essential that the software operates in a WindowsTM envi-

ronment, then several packages can automatically be ruled out.

Boustead, PIA and SimaPro 3.1 are all based in MS-DOSTM. This makes exportation into a spreadsheet package the only feasible way of incorporating results into a WindowsTM usable format. PRé Consultants do have plans to introduce SimaPro in a WindowsTM format during 1996, but the time scale has not been agreed.

SimaTool is a distant relative of SimaPro 3.1 (they both originated from a joint venture between CML Leiden University and PRé Consultants), and although SimaPro 3.1 is installed under MS-DOSTM, SimaTool is not. It requires REXX for the purposes of installation. REXX is the standard batch code language under OS/2 (OS/2 is a similar language to MS-DOSTM).

5 Network Capabilities

A facility available on some of the software packages is that of network connection. This allows several users access to the same database simultaneously. Packages which offer this function are Ecobalance UK's TEAMTM, SimaPro 3.1, PIA and LMS Eco-Inventory Tool. Both Boustead and Pira offer a site license for their software, allowing multiple users, but the packages are not designed for network operation.

6 Impact Assessment

Impact assessment is one of the most useful tools associated with any LCA software. Without it, the package is essentially a database with a glorified spreadsheet attached. Several packages offer some form of graphical representation of the impact assessment.

PEMS 3.0, SimaPro 3.1 have excellent facilities for graphical representation of impact assessment. They are adaptable, easy to use and have a choice of evaluation methods. EcoPro 1.3 and GaBi 2.0 offer some form of graphical impact assessment, but are less advanced. EcoPro 1.3 for instance, has much lower flexibility in terms of the graphical outputs available.

TEAMTM can display all inventory parameters included in an impact assessment, and list those excluded. This can be useful when comparing impact assessment results from different packages because different tools use different bases on which to calculate the impacts involved.

All the other packages reviewed in the report, excluding the Boustead model, LMS Eco-Inventory Tool and KCL-ECO offer some degree of impact assessment, but with no graphical output. For instance, PIA offers a form of impact assessment in that the user can specify a factor matrix (eg Greenhouse effect) for the output table.

7 Graphical Representation of the Inventory Results

Also useful for the purposes of clarification and report writing is some form of graphical representation of the inventory results.

Most packages do offer some form of graphical output. LCAiT 2.0 is one such package. Inventory data can be displayed on a basic graph, but it is very inflexible. The software which does not offer any direct graphical output either of an inventory or an impact assessment are Boustead's model, PIA and KCL-ECO, although data can be exported to a spreadsheet for manipulation and graphical representation of results (eg the Boustead model allows results to be shipped into ExcelTM via a graph macro). Two of the best packages in terms of graphical outputs are PEMS 3.0 and SimaPro 3.1.

8 Sensitivity Analysis

Few packages offer automatic sensitivity analysis. Most do not because the time taken to perform an accurate analysis on all parameters would be substantial. A package which does offer automatic sensitivity analysis is Ecobalance UK's TEAMTM. SimaTool also has an (optional) automatic sensitivity analysis procedure available. SimaTool also offers a facility to model alternative process parameters (including the functional unit) dynamically during the computation. This provides figures on how changing such parameters affect the LCA results. KCL-ECO provides semi-automatic sensitivity analysis, producing a basic sensitivity graph at the end of the tabular results section.

Basically, all packages indirectly offer this analysis since the user can always alter the process details slightly and compare the effects.

9 Units

Generally the units specified with the input details serve only as a means of tracking the flows through the system, and do not affect calculations. Thus there is no automatic conversion of units within the system. The exceptions to this are SimaPro 3.1 and SimaTool which do recognize like units and can convert them (eg grams to kilograms, but not m³ to kg). Boustead's model does require units to be consistent and provides a facility to aid the manual conversion of units.

Other methods can be used to track flows through a system and verify that each unit stage of an LCI is balanced. Both PEMS 3.0 and PIA have a mass balance window in the process block which shows if there is an imbalance in that step, thereby reducing the possibility of errors. TEAMTM has a function to test the consistency of systems to avoid incorrect flow connections, double counts, etc. KCL-ECO also has a method to discourage errors. The user must link an outflow of each process to an inflow of the next.

10 Cost

The packages themselves vary widely in cost. The least expensive complete package is that offered by PIA and the most expensive are those offered by Boustead Consulting and The Ecobilan Group (Ecobalance UK). Although the cost is arguably related to the volume of data that can be offered with the software, PIA do offer a volume of data, which they suggest is comparable to that of SimaPro 3.1. The costs and their approximate sterling equivalents (at the time of writing) are shown in Table 1. It should be pointed out that some of these prices are negotiable.

11 Geographic Limitation and English Language

The report examines software appropriate to European (and particularly UK) industrial LCAs. Therefore, the software reviewed in this report is of European origin. Not all the software is geared towards operation in English. Oeko-Base für Windows is only available in German.

There are a number of LCA software packages which have originated in the USA. Such packages include LiMS from Chem Systems, EcoManagerTM & REPAQTM both from Franklin Associates and DEAMTM (US) from Ecobalance Inc. These packages were not investigated for the reasons outlined above. DEAMTM (US) is similar to DEAMTM offered by The Ecobilan Group. EcoManagerTM and REPAQTM have data mainly appropriate to the United States. REPAQTM is designed for packaging materials and the associated product.

Table 2: Summary of all the specifications for each of the software packages

Specification	Boustead's Model	Eco-balance UK's TEAM™	EcoPro 1.3	GaBi 2.0	KCL – ECO	LCAiT 2.0	LMS Eco-Inventory Tool	Oeko-Base für Windows™	PEMS 3.0	PIA	SimaPro 3.1	SimaTool
Volume of data	v high	v high	low	high	low	med	low	low ^a	high	med	high	high
UK appropriate data	✓✓	✓✓		✓		✓			✓✓	✓	✓✓	✓✓
Windows™ based		✓	✓	✓	✓	✓	✓	✓	✓			
Network capability	†	✓	†	†	†	†	✓	†	†	✓	✓	†
Impact assessment		✓	✓	✓				✓ ^b	✓	✓	✓	✓
Graphical impact ass'mt		✓	✓	✓				✓ ^b	✓		✓	✓ ^c
Graphical inventory anal'	Via supplied Excel™ Graph Macro	✓	✓	✓		✓	✓	✓ ^b	✓		✓	✓
Auto sensitivity analysis		✓				✓						✓
On line help	See below ^d	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flow diagram capability		✓	✓	✓	✓	✓			✓	✓	✓	✓
Restriction input/output ^e	†	no limit	†	†	†	16	†	†	24	no limit	†	no limit
Demo Version		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

^a With the review of BUWAL data in June 1996, the volume of data will increase, as will the available process data
^b BUWAL 133 (Methodology of "ecological scarcity")
^c Graphical display of impact analysis and inventory analysis can be achieved via a spreadsheet export file
^d The Boustead model is not supplied with on line help. However, the model is supplied with a comprehensive user manual
^e Restriction on the number of inputs/outputs into a specific process card etc. This can be remedied by adding dummy cards
^f not specified

12 User Support

All the software, with the exception of Boustead's model comes with an on-line help facility built into the program. However, BOUSTEAD does provide a comprehensive user manual with the software [1].

Details on the user support supplied with software packages were not specified for KCL-ECO or SimaTool. All other packages offer some level of user support after purchase. This ranges from telephone support through user training to user associations.

13 Flow Diagrams

A system flow diagram is useful for showing what is included and what is excluded from the system boundaries. It also highlights how other unit processes are related to that producing the functional unit.

All the packages offer some capability for flow diagram development, except the Boustead model and LMS Eco-Inventory Tool. However, the range of detail of such diagrams is substantial. Some packages such as PEMS 3.0,

TEAM™, LCAiT 2.0, KCL-ECO and EcoPro 1.3 are flow-diagram based, so their associated flow diagrams are very advanced. GaBi 2.0's flow diagram is also quite developed. GaBi 2.0, EcoPro 1.3 and Ecobalance UK's TEAM™ offer a layered system diagram, in that higher levels of detail are reached by double-clicking on process blocks.

SimaPro 3.1, SimaTool, PIA, LMS Eco-Inventory Tool and Boustead's model are not flow diagram based. Thus, the detail contained within the flow diagram varies. As previously mentioned the LMS Eco-Inventory Tool and Boustead's software have no flow diagram capabilities. PIA's capabilities are very limited, but the diagram associated with SimaPro 3.1 is advanced. It offers several options in terms of the details displayed, and includes a monitor of emissions on each of the unit processes within the diagram. The output from SimaTool is similar to SimaPro's, but it has been reported that with large systems, SimaTool may not always generate a complete flow diagram. CML, who developed SimaTool suggest that this is not the case and that the complete flow diagram will always be generated, but the diagram can become very large and therefore difficult to read on a small computer screen.

The systems which are Windows™ compatible and whose inputs are flow diagram based, will allow the flow diagram to be cut and pasted into other applications, such as Word™. This facility is not available to packages functioning outside the Windows™ environment.

14 Burdens Allocation

When using LCA software for the purpose of generating industrial inventories, it is important that burdens allocation is very flexible.

The issue of burdens allocation does not seem to be a problem for any of the software available. It is generally the case that software packages allocate burdens on a mass basis, i.e. on the output product and by-product units entered by the user for each process. However, this is normally the default option, and the user can specify an alternative means of allocation. An exception is this rule is EcoPro 1.3 which insists the user specify the means of allocation for every process. There is no default option.

SimaTool offers up to six alternative means of emissions allocation including mass, value, energy and several other user-defined allocation options.

15 Transparency of Data

An issue with Ecobalance UK's DEAM™ is the transparency of data. Some of the data supplied by Ecobalance UK is locked, so although the user can employ the final figures, they cannot assess detailed process information. Presumably this is because the data is site-based data from a particular site, protected by a confidentiality agreement with The Ecobalan Group. This is not an issue with the other LCA databases. In many cases, the data is industry averaged to produce standard figures.

16 Input and Output Parameters

A number of the LCA software packages have restrictions on the number of inputs and outputs available to or from a process. Some, like PEMS 3.0 and LCAiT 2.0 get round this by using dummy process cards (as represented in Fig. 2).

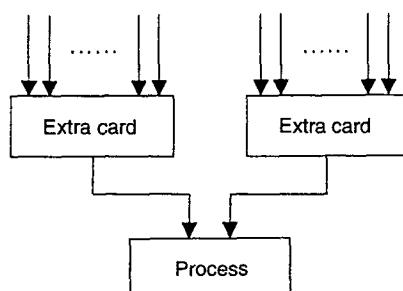


Fig. 2: Diagram representing how dummy cards can allow increased numbers of inputs into a unit process

PEMS 3.0 is restricted to a total of 24 input and output materials and energies associated with any one card, whilst that of LCAiT 2.0 is 16. However, with LCAiT 2.0 this restriction does not involve energy flows and emissions etc [1]. PEMS 4.0 will have no restriction on the number of inputs and outputs to a process card. TEAM™, PIA and SimaTool have no restrictions on the connections to a process. The other packages do not specify any restrictions.

17 Demo Version

Most of the software suppliers can provide a demo version of their software on disk. Boustead Consulting do not provide a demonstration diskette, but will arrange one to one demonstrations.

The Ecobilan Group has recently released a demonstration version of their revised software (ie TEAM™ version 2.0). LMS have also produced a demonstration diskette recently. Nearly all of the demonstration versions available are interactive. Those that are not interactive are the demonstrations associated with TEAM™ (version 2.0), GaBi 2.0 and LMS Eco-Inventory Tool. The Ecobilan Group do have plans to produce an interactive demo in the future.

18 Quality of Data

It is important to be able to compare the data supplied with different software systems. Assessing the geographic relevance of data to specific applications is straight forward, but factors such as accuracy and age of data are more difficult to gauge.

Data supplied is of two sorts. Either it is from published reports, or it is generated by the software supplier. Data that is generated by suppliers is often either restricted in transparency or is averaged in some way to protect the confidentiality of the sources from which it has been generated.

Critics of LCA have pointed out that average data is poorly suited to specific LCA investigations since accurate results should be site specific. Also, because there is no common legislation covering data generation, the variations in published data which has been calculated for similar applications can be substantial. That being said, many of the packages use the same data sources. For instance, BUWAL and APME (Eco Profiles of The European Plastics Industry) are commonly used.

Those that do not use average data (eg TEAM™), employ elaborate access restraints to prevent users from breaking this confidentiality. This of course affects the transparency of the data used in the LCA.

19 Updates

It is important to note that all the packages reviewed here are updated regularly. Many of them are expecting to release updated versions in the near future. With these updates, some of the information detailed in this review will no longer be appropriate.

For instance, The Ecobilan Group have recently released the latest version of TEAM™ and plan further updates this year. PEMs 4.0 is due out by the end of 1996. It will no longer be based in Excel™. Instead it will be stand alone, and the databases will be based in Access™. Burden categories will be considerably increased, with the option of user-defined burdens. Impact assessment and sensitivity analysis will also be improved and the option will be available to purchase data from other sources. PRÉ have plans to introduce SimaPro in a Windows™ format in the near future and KCL-ECO (2.0) operates in Windows 95™ or Windows NT 3.51™ and has now been released. The other packages reviewed are also regularly updated.

20 Conclusions

The basic function of all the packages reviewed in this report is the same. The only way in which they differ is in the method, speed, flexibility and information each package has when performing this function. Initially, every package will be difficult for the user to work with because it will only be after some time working with a package that a user will really get to understand how it works.

20.1 Geographic scope

The software reviewed in the report is European in origin. Although there are LCA packages developed in the United States, the geographical scope of the data is more limited and they are not appropriate for LCAs on European industries.

20.2 Software application

The key to picking an appropriate software tool is knowing the application. Originally, LCA software were designed to be useful to the packaging industry and now some have been adapted for more general use. The databases associated with such packages cover a wider cross-section of materials and processes than those geared towards packaging applications.

There are really four major players in the arena of LCA software in Europe. These are Boustead's model, Ecobalance UK's TEAM™, PEMs 3.0 and SimaPro 3.1. They currently have the largest market share and the greatest respect from the European LCA community. New software is arriving, and GaBi 2.0 and KCL-ECO are amongst the most recent arrivals. KCL-ECO is a less advanced package but seems to work very well. It has much to offer for the price, if impact assessment and graphical representation of results are not crucial.

Much of the software detailed in the report would be less suitable to industrial life cycle analysis than that offered by the suppliers named above. However, all four of the packages previously mentioned are suitable for industrial applications. The data contained on Boustead's and Ecobalance UK's models are particularly relevant to industry.

20.3 International application

The reputation and past experience of the software package is also important. If software has the reputation of giving questionable results it should be ignored. Generally the main software houses have a positive reputation. Both Boustead and The Ecobilan Group are leaders in the field. They have a strong position in Europe and are making headway into the US market.

If a package is required which will have applicability to the US, then the best option may be Ecobalance UK's TEAM™. The software they offer allows access to the largest volume of data available and can incorporate DEAM™ (US) [4] – the American equivalent of DEAM™.

PEMs 3.0 is also making headway into the American market, with associations with Franklin Associates.

20.4 Cost

The final parameter which affects the decision of which package to purchase is value for money. Both TEAM™ and Boustead's model can be purchased on a yearly license. These licenses are £8,700 and £10,000 respectively. However, with the TEAM™ packages, not all of The Ecobilan Group's vast array of data is included, and if specific data is required the fee must be negotiated. Boustead's £10,000 annual fee includes all the available software.

KCL-ECO and GaBi 2.0 are cheaper alternatives. They complete the same basic function but the software is less expensive. However, the user is sacrificing a large volume of data to reduce the cost.

If a cheaper option is the more attractive a compromise could be either SimaPro 3.1 or PEMs 3.0. Both these software have high European credibility and market share.

20.5 General conclusion

It is fair to say that at the current stage in the development of LCA as an environmental management tool, there are four main players in terms of software. These are

- The Boustead model
- Ecobalance UK's TEAM™
- SimaPro 3.1, and
- PEMs 3.0

Acknowledgment

The authors wish to thank all those suppliers who took time to review the information contained in the complete LCA Software Review [1], from which this article was extracted, and for the feedback which they supplied.

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